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Cover: Man has long dreamed of harnessing the sun for his own use. Today the dream has become almost a necessity. If the current level of energy production is to be increased—or even maintained—in the future, new sources must be used. One possible solution is to convert the sun's energy into electric power. See "Energy Research: The Long-Term Perspective" on page 12 for more on this subject.

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The Institute for Materials Research
The Institute for Applied Technology
The Institute for Computer Sciences and Technology
Center for Radiation Research
Center for Building Technology
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Computers Automate Jet Engine Tuneups

COMPUTER technology, rapidly becoming a part of everyday life, will soon be able to take over a complicated test of the fuel control mechanism in jet engines.

In a project sponsored by the Propulsion Ground Support Equipment Branch of the U.S. Naval Air System Command, the National Bureau of Standards has developed computer equipment and programs designed to make these tests faster, easier and more dependable.

The fuel control test, which must be performed periodically when the jet's engine is overhauled, can take up to 200 hours of a mechanic's time when performed manually. Yet the test is too important to overlook; if the engine's fuel control is malfunctioning, the jet may not get off the ground.

Although the NBS system was designed for the Navy's jet planes, it can be modified for use in testing other engines. The system, expected to be in use by early 1976, will be

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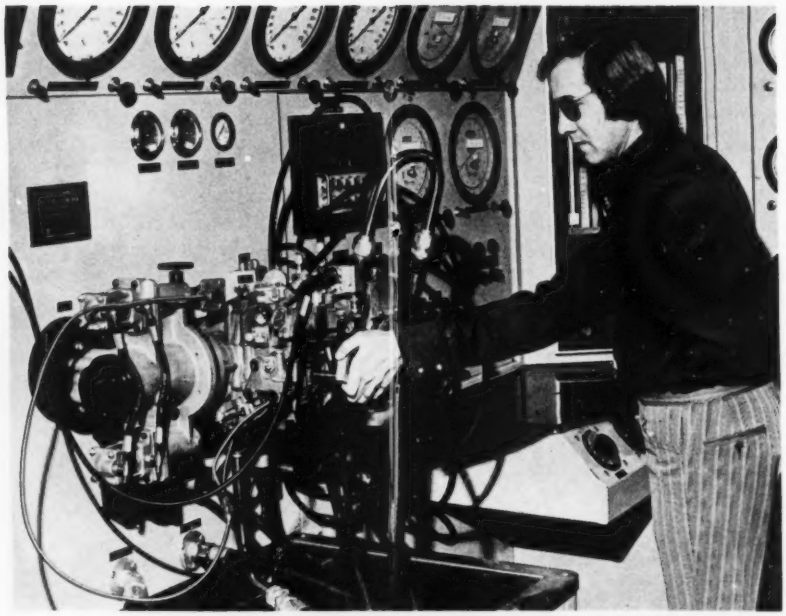
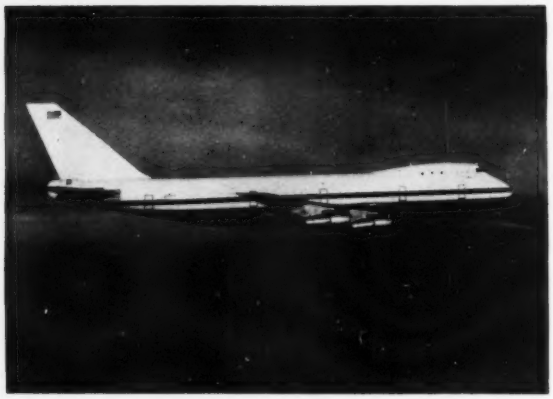
Bureau researchers demonstrate how the NBS-developed computer system can help technicians calibrate a jet engine fuel control, shown mounted on a test stand, in half the time required for manual calibration.





JET ENGINE *continued*

used at two Navy ground support bases to aid testing of military aircraft.

The computer software system was designed by William Haight of the Institute for Basic Standards (IBS) and Helen Hawes of the Institute for Computer Sciences and Technology (ICST). They presented a paper on their project to the 1974 Automatic Support Systems Symposium for Advanced Maintainability in San Diego, California. The hardware system design team was lead by David Baker of IBS, with support from Alfred Koenig of ICST and Victor Brame of IBS.

Fuel Control is Important

The jet engine's fuel control, a device weighing about 25 kg. (55 lbs.), works much like an auto's carburetor in controlling the fuel flow from the main engine pump to the engine burners.

The fuel control monitors engine and fuel conditions, including pressure, temperature and speed, with sensors connected to a series of cylindrical 3-dimensional cams. Cam schedules, which are the "brains" of the fuel control, provide a predetermined response to one or more engine conditions while avoiding fuel flowrates that exceed engine operating limits.

Changing conditions in the engine cause the cams to re-position themselves. When the pilot pulls on the throttle to accelerate or decelerate the plane, the fuel control integrates his thrust request with the engine conditions indicated by the positions of the cams.

"In this way," said Haight, "the fuel control positions the metering valve to deliver the correct fuel flowrate for the needed thrust."

Both commercial and military aircraft must have their fuel controls calibrated every time their engines are overhauled. The manual calibration process is lengthy, complicated and difficult for the less experienced mechanic.

Manual Calibration

To calibrate the engine's fuel control, the mechanic works at a large "test stand," manipulating dials and reading gauges to simulate engine operating conditions. The test stand has its own fuel tank and pump; the fuel is recycled instead of being burned.

"When it's placed on the test stand," said Hawes, "the fuel control thinks it's in an engine. The operator sets up different test conditions to see if the fuel control delivers the right amount of fuel for each of 200 test conditions, and makes various mechanical adjustments if needed."

These "test points" involve varying and combining five engine parameters: speed, burner pressure, turbine inlet temperature, compressor inlet temperature and power lever angle.

After setting up each test point, the operator reads the fuel flow for that point. If the flow is not correct, he adjusts the fuel control. The adjustment may involve repositioning a cam, or adjusting the bellows tension on a pressure-sensing mechanism, or other manipulations.

Calibrating with Computers

The computerized calibration system developed by NBS does almost everything except go into the fuel control with a screwdriver to adjust it. It automatically sets up test conditions, reads and records the results of each test and analyzes the test results as correct or incorrect.

In the final system, a completely programmed "minicomputer" will be installed in a computer room and connected via cables to the existing test stand. One minicomputer can service up to five test stands without any noticeable delay in operating time, due to the "real-time" nature of the system. Each test stand will have its own teletype and cathode ray tube (CRT) system for operator-computer interaction.

"The operator uses the teletype to talk to the computer, and the computer talks to him over the CRT," explained Hawes.

When the operator punches "G" for "go" on the teletype keyboard, the computer's program begins running the first test automatically. The program is able to activate test stand mechanisms by means of "stepping motors." The computer program "tells" the motor how many "steps" to advance to simulate a particular temperature, speed or other condition.

When the first set of test conditions is simulated, the computer reads the test results by means of transducers. "The stepping motors are the computer's arms, and the transducers are its eyes," said Hawes.

Results of the test appear almost instantly on the CRT and are recorded on paper by the teletype. This tells the operator whether the fuel control is functioning properly under each test condition. Color-coded lights above the CRT are used to flash operational status of test stand and computer hardware systems.

The computer runs the entire calibration test in this manner, leaving only the final adjustment process to the operator. If the operator needs to do a special test that is not programmed, he can punch "M" for "manual" and interrupt the automated procedure at any time.

Advantages and Implications

The ease with which an operator can perform the computerized calibration is important to the Navy, where fast turnover in skilled personnel is a problem. "An inexperienced operator could run this system," said Haight, "and the tests would be set up exactly the same way every time."

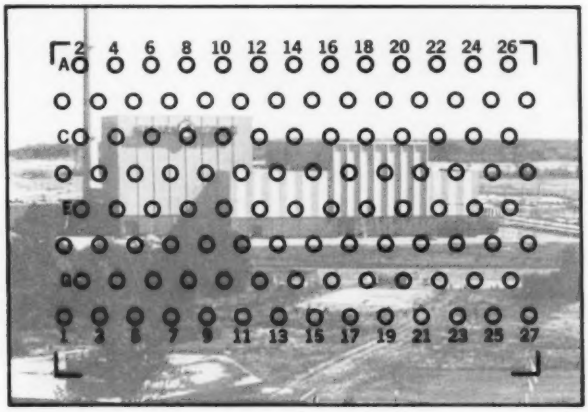
Computerization will also save time. "Our target was a 50 percent savings in time, and we feel we'll be able to meet that target," Haight said.

Unlike the manual procedure, the computerized procedure records all the test results quickly, accurately and reliably.

By using modular programming in standard FORTRAN language, Haight and Hawes have designed the system to be transferable to other types of engines. "The software design is applicable to almost any system," said Hawes. "The commercial airlines are interested in the approach, and one airline has purchased a similar automated system."

The transferability of the NBS system could save the government money in the long run, according to Haight. "Usually whenever the Navy gets a new type of engine, it buys all new maintenance equipment too," he said. "We tried to design the system so that it can be used in newer engines with only slight modifications." □

NBS Camera Keeps Eye on Nuclear Fuels



The NBS camera is designed to protect fuel used in nuclear power plants. Heart of the camera is this array of 108 photocells, 10 of which can be selected to detect motion in areas of interest.

NUCLEAR materials have become increasingly valuable today for their use in energy-producing systems. However, the growing amounts of these nuclear materials increases the risk of diversion from peaceful uses to the development of nuclear weapons and other nuclear explosive devices. As a result of the Treaty of Non-Proliferation of Nuclear Weapons and other treaties and agreements, the International Atomic Energy Agency (IAEA) is responsible for safeguarding nuclear material at facilities in a large number of countries throughout the world in order to provide assurance to the international community that these nuclear materials are not being misused. To help meet its growing responsibilities, the IAEA, supported by countries party to the treaty, is developing new and improved safeguard and surveillance systems.

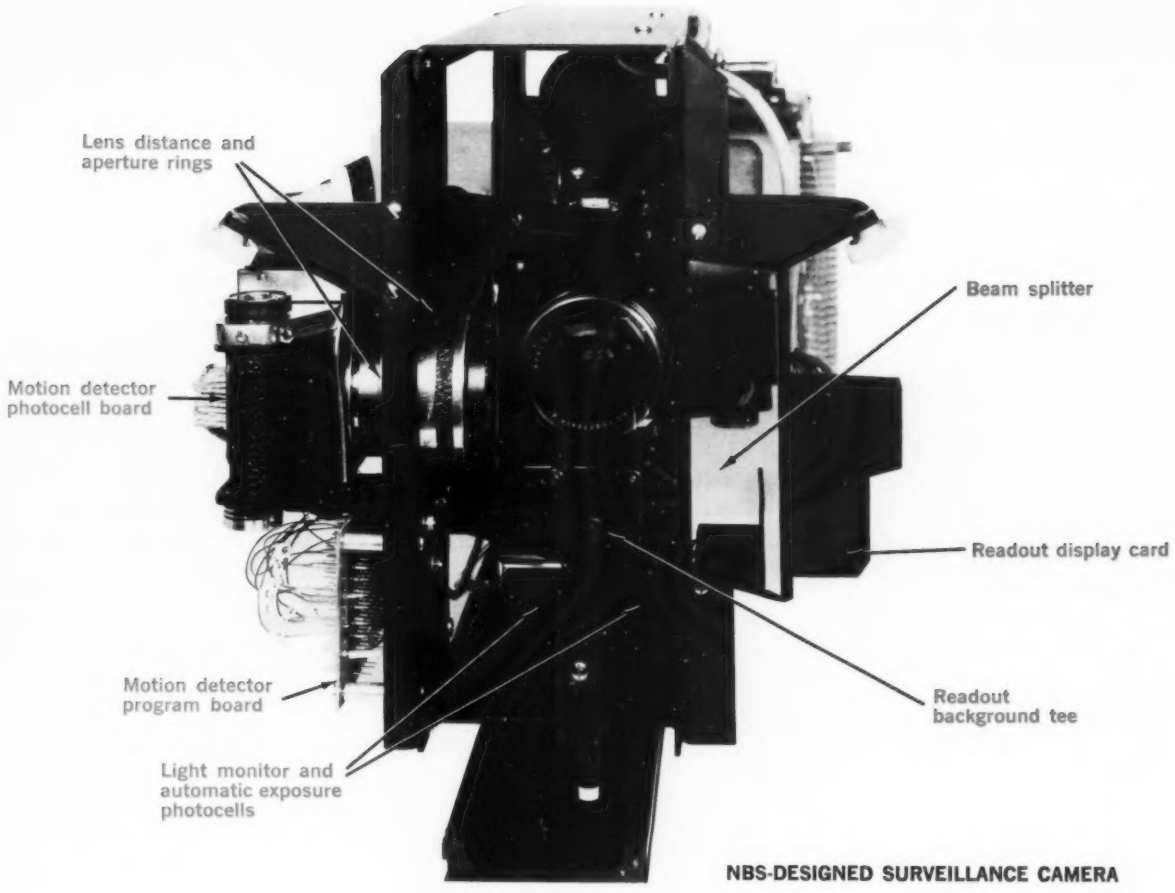
A special tamper-resistant surveillance camera for use in safeguard systems has been designed and built at the National Bureau of Standards under joint sponsorship by the IAEA and the U.S. Arms Control and Disarmament Agency. It is one of a number of instruments and techniques under consideration by IAEA in safeguarding nuclear materials. After undergoing field testing at several locations in the United States, the camera is now being tested in Europe.

"Unlike many security and surveillance systems, there is nothing secret about the NBS camera system," says NBS electronic engineer Owen Laug who built the camera with engineer Kenneth Yee. This is because the camera is to be used in many countries and it is unlikely that a secret system would be acceptable.

Silvered Lining

The major tamper-resistant feature of the camera is its special casing. The camera is enclosed in a cast acrylic tube which is coated with aluminum on the inside, giving the camera a silvered or mirrored appearance from the outside. Efforts to remove film or tamper with the camera mar the mirror coating, which is not easily restored to its original condition. Thus, by examining the mirror coating, an inspector can see if the camera has been disturbed. In addition, the cylinder cannot be opened without breaking a seal which is placed between the walls of the cylinder and the rear cover plate. Replacement of the cylinder with a duplicate is not possible without changing the identity of the seal.

Removed from its special tamper-



NBS-DESIGNED SURVEILLANCE CAMERA

resistant case, the camera looks much like an ordinary 16 mm motion picture camera. And, in fact, it is just that—with some special differences. For one, the camera has been modified to operate in a single frame mode, that is, one picture for each time it is triggered.

The second, and most important, feature of the camera is its system of "motion detectors" based on an array of 108 photocells and accompanying electronic circuitry. The motion detectors respond to a rate of change in luminance (the amount of light reflected from an object). Of the 108 cells, up to 10 can be pre-selected to detect motion in the areas of interest. This feature of the camera reduces the number of photographs that an inspector must examine, since only those events of special concern are recorded. Furthermore, the feature detects attempts at deception, such as insertion of a false scene in the camera's field of view or movement of the camera.

Right Track

Typically, for instance, the camera might be used in nuclear power plants, uranium enrichment plants, storage areas for irradiated nuclear fuels and facilities which reprocess these fuels. Whenever an activity—for example, a crane removing reactor fuel from a storage area—occurs in the areas programmed, the camera will take a photograph and record the time and date on the picture frame. In addition, the camera is also programmed to take photographs periodically, perhaps once an hour, regardless of whether motion occurred. A dot on the frames which are motion-triggered enable an inspector to distinguish motion photographs from time-triggered photographs.

"The camera is not designed as an alarm system," Laug stresses. At a suitable intervals, an IAEA inspector would examine the camera case and all photographs that had been taken since his last visit. The photographs—together with other safeguards information—would help reveal whether unusual activity had occurred. The system is designed to run unattended for about 3 months—4,000 picture frames—and can operate during short periods of power failure.

IAEA is looking at a variety of systems, according to Laug, and the NBS camera is one of many. Improvements must still be made. "Right now, it's a tool to learn whether or not we're on the right track in surveillance systems," Laug says. □

Modern day criminologists have a far different task than that legendary supersleuth Sherlock Holmes who, by using the slimmest piece of evidence and his remarkable powers of deduction, solved crimes and foiled crooks.

Crime Labs Aided by NBS Glass Standard

TODAY, forensic scientists characterize physical evidence found at the scene of a crime by supplementing observation and deduction with complex techniques requiring the use of equally complex instruments.

A survey in 1973 by the Law Enforcement Standards Laboratory (LESL) of the National Bureau of Standards showed that many crime labs made highly "precise," or repeatable, measurements, but the measurements were not always "accurate," that is, close to the "true" value. When measurements are precise but not accurate, there is no way to compare data obtained on different instruments, or at different times. This could mean, for example, that a measurement made on a sliver of glass found at the scene of a hit-and-run accident could not be compared to a measurement made several weeks later on glass from a suspect car.

More accurate, as well as more precise, characterization of glass evidence by crime labs will now be possible as a result of a new Standard Reference Material (SRM) developed at NBS. The SRM is used for calibrating refractometers, the instruments used to characterize glass evidence, and is designed specifically for making measurements on automobile headlight glass. Development of the SRM at NBS was supported by the National Institute of Law Enforcement and Criminal Justice of the Department of Justice through LESL.

Glass Slabs

Called SRM 1820, Refractive Index Glass, the new NBS SRM consists of two rectangular glass slabs: a slab, which is polished on two faces, in-

tended for checking the performance of refractometers; and an unpolished slab, which can be broken into fragments, intended for microscopic determination of the refractive indices of immersion liquids. Both slabs will be used by forensic scientists for calibration purposes in a technique known as the "immersion method" of characterizing glass.

In this method, the fragment of glass thought to be from an auto and found at the scene of the crime is placed on a glass slide or in a suitable reservoir that is mounted on the stage of a microscope. The fragment is immersed in a liquid having a specific and known refractive index (a value related to a material's ability to "bend" light passing through the material). Then, looking through the microscope, the scientist can match the refractive index of the liquid and the glass by changing the concentration of the liquid, by varying the temperature, by varying the wavelength of the light source or by a combination of these techniques. When the glass disappears, the sample has the same refractive index as the liquid. He then measures the refractive index of the adjusted liquid using a refractometer, thus giving him the refractive index of the evidence. In this way, the scientist can distinguish the automobile headlight glass from other types of glass, such as window plate glass, which has a different refractive index. This is called "classifying" the evidence.

If a sample of glass from a suspect automobile headlight is also available, the forensic scientist may perform the measurements on the evidence and the suspect glass at the same time. If the two pieces of glass have the same refractive index to four or five decimal places, this fact, coupled with other evidence available, may enable the scientist to conclude that the evidence came from a specific, suspect automobile This is known as "individualizing" the evidence.

SRM 1820 is used to ascertain the refractive indices of the liquids used to make the measurements as well as to calibrate the refractometer. By improving the accuracy of the measurements, this SRM will increase the ability of forensic scientists to classify and individualize automobile headlight evidence by refractive index measurements. SRM 1820 will also help scientists define the reliability of the characterization measurements.

Individualizing Evidence

Individualizing glass evidence using refractive index measurements is very difficult to do for automobile headlights, explains physicist Irving H. Malitson, who developed and prepared SRM 1820 with coworkers Marilyn J. Dodge, Jacqueline Cooke, and Joann M. Guyton in the Institute for Basic Standards. This is because all headlight glass has a refractive index around 1.48, so it takes very precise measurements to distinguish differences between glasses. Only three companies manufactured headlight glass for cars sold in the United States prior to 1971 and only two companies are making that glass now, Malitson says.

An important discovery by Malitson in the course of his work was that refractive index measurements can be used to differentiate between the newer glass (since 1971) made by one of the two companies from other headlight glasses. However, precise measurements are required because the differences only begin to show up in the third decimal place of the refractive index.

Other Uses

Although SRM 1820 was developed primarily for forensic science laboratories, it will also be helpful to many other industries that use refractometers to determine product purity and quality and for process control. About 5,000 refractometers are in use today in the food, sugar, glass, paint, plastic, pharmaceutical, petroleum, chemical and optical industries and in universities and research laboratories. SRM 1820 is certified for refractive index at 13 wavelengths ranging from 0.4047 to 0.7065 micrometers. The two glass slabs, each measuring 25 mm by 13 mm by 7 mm, are available as a unit for $61 from the NBS Office of Standard Reference Materials, NBS, Washington, D.C. 20234. □

Survey Results in New Data on Household Fires

*by Benjamin Buchbinder**

DURING the year ending April 15, 1974, an estimated 5,575,000 fires occurred in households in the United States. These statistics are based on a household survey sponsored by the U.S. Consumer Product Safety Commission and the National Bureau of Standards. The survey was "piggybacked" onto the Census Bureau's Current Population Survey (CPS) and was based on 33,856 U.S. households. The survey, which was conducted during the week of April 15, 1974, asked the respondents to recall the fire experiences of household members that occurred between April 1, 1973 and the week of April 15, 1974.

The purpose of the survey was to determine the number of household fire accidents and injuries that occur annually in the United States. Information was obtained on the ignition sources and the items involved in the fires. An accident was considered a fire if it emitted smoke or flames and was not started intentionally. The smoke or flames may have been confined to an appliance and did not necessarily result in other property damage.

How was the survey conducted? A series of screener questions was asked to determine whether or not any member of the household had experienced a fire or a fire-related injury since April of the previous year. For every fire incident and/or fire-related injury identified by the screener questions, a detailed incident and/or injury questionnaire was completed.

What was the survey scope? What statistical population was sampled? The survey covered all fire incidents experienced in 1 year by household members in their current residence or previous residences. In addition to fires in the home, the survey included fires in garages, sheds, barns and other buildings on the property. Also included were fires in vacation homes (and buildings on the property) and both motor vehicles and boats owned by household members. Specifically excluded from the survey were fire incidents in business establishments, public places, government buildings, vacant housing units, common areas in apartments (such as hallways,

*Mr. Buchbinder is acting Chief of the Office of Information and Hazard Analysis at the National Bureau of Standards.

stairways, laundry rooms and trash rooms). Unavoidably excluded by the nature of the survey were the serious fires in which all members of the household were killed or hospitalized at the time of the survey.

For the injury portion of the survey, injury data was solicited with regard to any fire, household or otherwise, in which a household member was injured. Nevertheless, the household orientation of the survey made it impossible to accurately reflect those injuries which took place away from home. A single respondent in a household would not be expected to have complete knowledge of the fire injury experience of other household members away from home.

How accurate are the national estimates? In survey work, two general classes of error—sampling and non-sampling—exist. The sampling error represents the random variation in samples of a given size for a given sampling plan. This variation may be expressed in probabilistic terms as a standard error or as a confidence interval for a given estimate. The non-sampling error includes response error, non-reporting error and processing error. Part of the response error is related to the recall period. Whereas the sampling error is random and probabilistic in nature, the non-sampling error is not random and it is not easily measurable.

This survey represents a significant contribution to the measurement of national fire incidence; however, one must be careful to recognize the limitations of the data. Although the sample size of 33,856 households is large, the occurrence of a fire is a rare event, statistically. Therefore, although we may have confidence in the precision of estimates of large totals, such as the total number of fires, when we estimate sub-totals, such as fires involving a given product or a given room in a house, the precision is sharply degraded. We are awaiting accurate computation, by the Census Bureau, of the standard errors to be applied to estimated totals.

We are, however, able to look at some confidence intervals computed by approximation. An estimated total of 10,000 occurrences would be subject to variation of ± 140 percent, an estimated total of 50,000 occurrances would be subject to variation of ± 44 percent and an estimated total of 5,000,000 occurrences would be subject to variation of only ± 6 percent, at the 95 percent confidence level. In terms of injury data, the precision of this survey is much lower, since a fire-related injury is a rare event among rare events. Unfortunately, a survey of this size does not permit accurate estimation of injuries, and one must be satisfied with fair precision in estimating total injuries and not lend inappropriate credibility to estimates of subcategories.

Now to the survey data. The data analysis is incomplete, but some interesting preliminary results have been compiled. The raw survey totals include 2,233 households reporting

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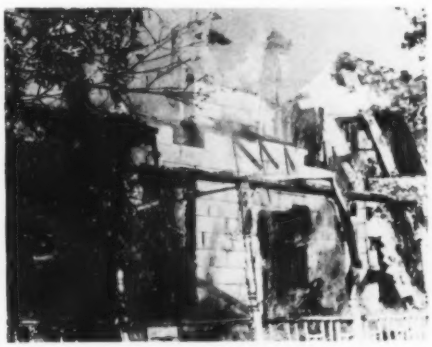

Energy Research:

The Long-Term Perspective

*by Dr. Robb M. Thomson**

THE energy crunch has been with us now for a bit longer than a year and has produced a tremendous amount of analysis. This outpouring has accentuated greatly detailed analyses of supply and demand, and the argument has perforce become exceedingly complex.

In some ways, the energy problem is, indeed, complex in the extreme. However, I'm dealing with the impact of energy research and development 10, 20, 30 years from now, where it is difficult and perhaps foolhardy to develop computerized projections. So I want to simplify the problem to its essentials, and then ask what kinds of research and development should we be interested in. In the words of Dr. Alvin Weinberg, we want to develop "scenario-proof" conclusions about the energy problem—conclusions which are independent of the details of specific plausible situations. Along these lines, I have drawn heavily on the approach and philosophy developed by Weinberg and his associates in the Energy Research and Development Office of the Federal Energy Administration.

* Dr. Thomson is a senior research scientist in the Institute for Materials Research at the National Bureau of Standards. He was recently on detail to the Energy Research and Development Office, Federal Energy Administration.

Our first scenario-proof conclusion is that oil and gas, which currently form the primary base of the U.S. energy system, are very limited resources. According to estimates, we are already near the peak of production in both.

In the middle range, sufficient coal and oil shale remain to form a fuel base. However, in order to use these other fossil fuels, methods for substituting them for oil and gas will have to be found—for example, synthetic clean fuels or expanded central station electricity—and new environmentally benign methods of resource recovery will be necessary.

In the long run, society has no choice but to turn to non-fossil energy: breeder reactors, fusion, solar energy and geothermal energy. In the shorter run, factors such as environmental constraints may necessitate a more rapid transition to these ultimate energy forms. Although the breeder technology may be close at hand, solar energy for electric power, geothermal and fusion are still so imperfectly understood that no national reliance on them can yet be permitted.

R&D Priorities

These scenario-proof conclusions or axioms are very broad, but nevertheless they can form the basis for research and development policy. First of all, it is essential to stretch our oil and gas resources as far as possible by developing advanced methods for their recovery. Presently, a large fraction of the oil must be left in the ground because it is not economically recoverable. It is estimated that joint government-industry programs could make possible the recovery of an additional 4.77-9.54 $\times 10^9$ cubic meters (30-60 $\times 10^9$ barrels) of oil 5-10 years sooner than would otherwise be possible.

In the mid-term, when a shift away from oil and gas is inevitable, methods for substituting coal for oil and gas on a large-scale will be required. Coal gasification and liquefaction programs are already underway to accomplish this. However, the government has given scant attention to methods for recovering oil from shale

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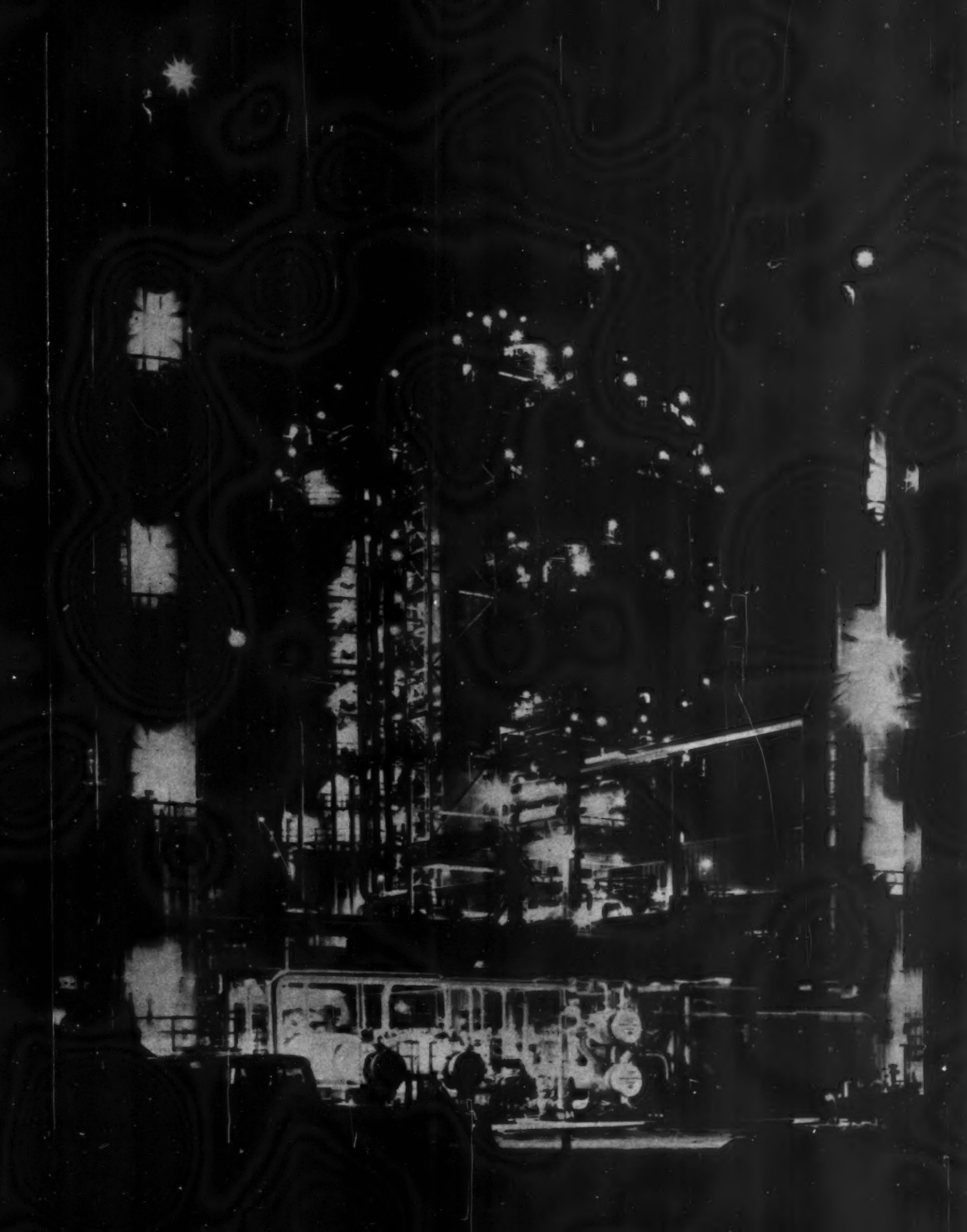
Solar energy collector and storage system under construction at NBS.



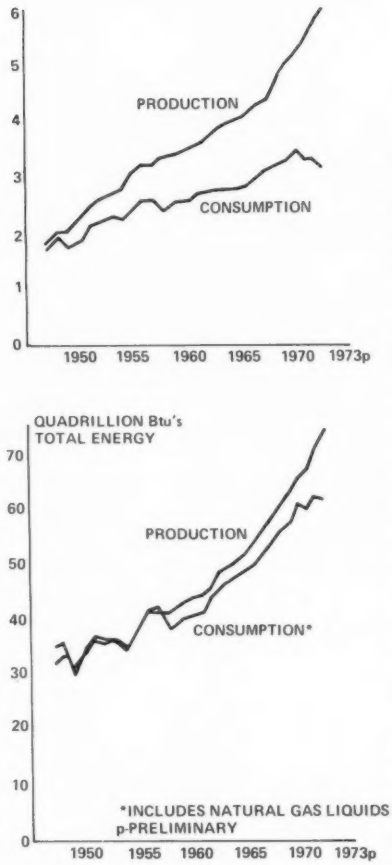
by in situ techniques which are necessary to avoid unacceptable environmental damage.

Environmental issues pervade the entire energy picture, and the science and measurement methodology underlying environmental standards are at least as important as the energy technologies themselves. However, beyond this is the long-term problem concerning the ultimate limits on energy production in terms of climatological effects. At present energy use is only about 1 part in 20,000 of the energy absorbed from the sun but this ratio is growing rapidly. We need to know where important micro climate effects as well as macro climate effects may be induced. These problems are extremely difficult, but must eventually be solved.

Government Role in Automotive R&D

Let me now turn to two areas of special personal interest—automotive R&D and solar energy. I believe automotive research and development has special interest for two reasons. Currently, automobiles use about 30 percent of the total petroleum consumed in this country and about 90 percent of that energy is wasted in the thermodynamic sense. Secondly, we have already seen that in approximately 20-30 years, oil may be disappearing as a major source of fuel, and new types of vehicles powered by a substitute fuel will be necessary. A recent and very important study has just been performed by the Department of Transportation and the Environmental Protection Agency that estimates automobiles with fuel economies of about 8.5 kilometers per liter (20 miles per gallon) are feasible by 1980-1985 with some increase in price. These economies are achievable by a combination of lighter body weight and more efficient engines.

The administration is currently engaged in jaw-boning sessions with the automakers to have voluntary fuel efficiency standards adopted for new cars between now and 1980-1985, and various congressional inquiries may lead to designated standards. One hopes the standards or goals



MAXIMUM 1985 PRODUCTION LEVELS UNDER BUSINESS AS USUAL (BAU) AND ACCELERATED DEVELOPMENT (AD)
(AT $11 OIL)

SOURCE	BAU POTENTIAL	AD POTENTIAL
Oil	15.0 million barrels/day	20.0 million barrels/day
Natural Gas	23.4 trillion cubic feet/year	29.3 trillion cubic feet/year
Coal	1.1 billion tons/year	2.1 billion tons/year
Nuclear	234 million kilowatts	275 million kilowatts
Coal Gasification	0.5 trillion cubic feet/year	1.0 trillion cubic feet/year
Coal Liquefaction	—0—	500,000 barrels/day
Shale Oil	250,000 barrels/day	1.0 million barrels/day
Geothermal	6000 megawatts	15,000 megawatts
Solar Heating & Cooling	0.3 quadrillion Btu's	0.6 quadrillion Btu's
Solar Electricity	41 million MWh/yr	151 million MWh/yr

Source: Project Independence Report, Federal Energy Administration

Photo courtesy of National Science Foundation.

Geothermal sources offer yet another potential means for increasing energy production in the future.

adopted by either route will be based on a more reasonable and feasible technical base than has been true of the earlier goals for pollutant emissions.

As oil is depleted, the pressure will be great for conservation of this oil and the prudent use of the synthetic fuels which will replace it. At the same time, emission control of pollutants will also retain a high priority. At this time, it appears that two types of automobiles may be required: one type with some form of highly efficient heat engine burning a synthetic fuel and an electric car as the second type.

The synthetic fuel car looks like a good bet for long distance travel. However, a better engine than the present gasoline engine will probably be required. I mentioned earlier that current gasoline engines are only about 10 percent efficient overall. Improvement to the 30 percent level should be feasible, in addition to which more savings should be possible through brake regeneration and more careful design of transmissions and streamlining. A great deal of R&D research and development on both the emission and efficiency fronts is necessary before practical examples will be available.

In the case of the electric car, energy storage is the crucial element. Actually, energy storage is à much wider issue than for automotive propulsion, because utilities have difficulty following the daily fluctuations in electric power demand and must now either buy special peaking power generation units or store energy by pumping large quantities of water between a high and a low reservoir. Various forms of storage have been proposed—batteries, fly wheels and heat sinks. Another form of storage (or is it a synthetic fuel) is hydrogen production. The battery looks like the most feasible alternative for automobiles, but much development work is still necessary on the battery itself and on its marriage to the car.

There is an obvious role for the government in this area. The long-term character and magnitude of the development, its ramifications in fuels as well as engine development, and its environmental and safety aspects place the R&D program planning well beyond the purview of any individual private automaker.

Solar Energy

The total solar radiation received by the earth is about 175,000 terawatts (Tw) while the U.S. production is about 2.5 Tw. Approximately 30 percent of this is re-radiated, about 47 percent is directly converted to heat, about 23 percent into water cycles, 0.2 percent into winds and waves and only 0.02 percent into photosynthesis. If we take the figure of 150 watts per square meter as the average daily insolation on the United States, about 60,000 square miles would be required to generate at 10 percent efficiency all the current U.S. energy needs. This area is about 2 percent of the lower 48 states.

Thus there is plenty of solar energy available. But, how do we make use of it? The major problem is that it is available to us as a low-temperature source, and it is very diffuse. Normal engineering development has historically gone in exactly the opposite direction, toward high temperatures and high intensity. Hence, the engineering for solar energy tends to large scale installation and entails a very difficult fight over costs.

The more interesting question is whether solar energy can ever be made a practical source of electricity. A number of methods have been proposed—the most practical of which is the old-fashioned windmill. Wind generators of 10 megawatt capacity are now being planned by the National Science Foundation and the National Aeronautics and Space Administration. Another possibility is the photovoltaic process, which in my opinion has the greatest long-term potential. However, with a present cost of about $20 per watt, a reduction in cost by a factor of about 100 is needed for central station power.

In summary then, there is a long history of estimating how much oil we have. However, the history so far has been a series of episodes of crying wolf, only to find that much more oil was eventually discovered, and the wolf wasn't really there. But we can be certain that a real wolf exists and will some day be on our doorstep. The question is when and how are we preparing for it. □

HIGHLIGHTS

Fire Control Act

President Ford recently signed the Federal Fire Prevention and Control Act which amends the 1901 organic act of NBS by establishing a Fire Research Center at the Bureau. The Act also creates a Federal Fire Prevention and Control Administration in the Department of Commerce. NBS' Fire Research Center will conduct research on all major aspects of fire. In supporting the national effort to reduce fire losses by 50 percent in the next generation, the Center is charged with developing the technical base for improved fire safety standards and design concepts and with recommending fire safety procedures.

Windows and People

As part of a project to determine the impact of exterior building design on energy consumption, NBS is investigating the psychological benefits for people of windows in buildings. Although the simplest solution for reducing energy consumption is the complete elimination of windows, research shows that a view out, providing contact with the external world, is of great importance to building occupants.

Checking Bike Forks

NBS is inspecting bicycle forks for the Consumer Product Safety Commission (CPSC), which ranks bicycles first among products associated with consumer injuries—particularly to children under 16. About 371,000 emergency hospital cases a year are bicycle related

The NBS checks for fatigue cracks, using a dye penetrant examination under ultraviolet light, are part of CPSC's continuing process for insuring the marketing of safe products.

Fossil Fuel Standards

NBS has issued two new Standard Reference Materials (SRM's)—SRM 1632, Trace Elements in Coal, and SRM 1633, Trace Elements in Coal Fly Ash—at the request of the Environmental Protection Agency.

Increasing interest and emphasis on the effects of trace elements emitted into the atmosphere, and the need for performance and emission standards in enforcing the Clean Air Act as amended in 1970, prompted the development of the SRM's. These SRM's are intended for use in the analysis of coals, coal fly ashes and similar materials; in the development or refinement of analytical procedures; and in interlaboratory comparisons.

To obtain SRM information, write the Office of Standard Reference Materials, B311 Chemistry Building, NBS, Washington, D.C. 20234.

NBS/BRH Teletherapy-Dosimetry Project

The Bureau of Radiological Health (BRH) and NBS are engaged in a nationwide voluntary study of the dose calibration of cobalt-60 teletherapy units. Irradiated and control dosimeters are being sent to NBS for a determination of the difference between the prescribed dose and the dose actually delivered.

The project has a twofold purpose. NBS is studying the adequacy of the methods for making national dosimetry standards available to the public. BRH is concerned with the safe and effective use of therapeutic radiation and will use the project results to identify areas in which it could make a contribution toward improving medical care and reducing unnecessary radiation exposure.

Standards for Handcuffs

NBS has developed a standard for metallic handcuffs that includes requirements and methods of test for weight, dimensions, strength, corrosion resistance and double locking. The standard will be published by the National Institute of Law Enforcement and Criminal Justice of the Department of Justice, which sponsored the work leading to the standard.

The FBI Academy plans to recommend the use of the standard in procurement and to use the technical content of the standard in instructional material.

Software Engineering Handbook

A practical technical guide for designing computer software will be developed by NBS and the National Science Foundation. To be called "The Software Engineering Handbook," the volume will be a concise compilation of state-of-the-art knowledge.

The Handbook will be produced in collaboration with the professional computing community. Chapters will be issued in preliminary form as NBS Technical Notes later this year. □

NBS to Hold Measurement Seminars

SEMINARS and workshops included in the 1975 series of NBS Measurement Seminars were announced recently. They are scheduled to be given at the NBS laboratories in either Gaithersburg, Md., indicated by (G), or in Boulder, Colo., indicated by (B). The announced topics and dates are:

- Calibration and Use of Piston Gages (G)—As demand requires.
- Antenna and Field Strength Measurements (B) —Spring 1975 (Dates to be announced).
- Precision Thermometry Seminars (G)—March 10-14, 1975.
- Low-Frequency Electrical Measurements (G)— April 21-24, 1975.
- Frequency Standards and Clocks: Characterization, Usage, Problem Areas (B)—August 25-27, 1975.

The seminars and workshops are part of an NBS effort to provide advice and assistance on measurement and calibration problems to a growing number of laboratories. The main aim of the program is to help these laboratories trace the accuracies of measurements needed for research work, factory production or field evaluation to NBS standards.

Each seminar lasts from 2 to 4 days, and its meetings are devoted to lectures, group discussions and laboratory demonstrations. Participation is open to a limited number of persons from measurement and standards laboratories who meet appropriate prerequisites in the areas of education, work experience and current professional activity. Persons wishing to attend any of these courses should send a letter of application to the individual named in the course descriptions below. Letters should include details of the candidates qualifications in terms of the stated prerequisites.

Acceptance of qualified applicants, on the basis of first come first served, other things being equal, will be made by letter not later than 4 weeks prior to the scheduled date of the course. Detailed information on schedules and housing will be available at that time.

Calibration and Use of Piston Gages

These seminars are held to help industrial and other users attain the highest possible accuracy in pressure measurements with piston gages. The seminar is directed at engineers and senior technicians. The 2-day seminar presents information on the theory of piston gages, elastic distortion, design and types, calibration of controlled clearance piston gages, calibration by cross-float, hydrostatic weighing and transducer calibrations. The seminar closes with a tour of the laboratory, for those who are interested, and a discussion of research and development work in the field of pressure measurements. The courses begin on time at 9:00 a.m. and end about 5:30 p.m.

Attendance will be limited to eight per course. The fee for the course, which will be given as demand requires, is $105. Apply to: Dr. Peter L. Heydemann, Chief, Pressure and Vacuum Section, National Bureau of Standards, Washington, D.C. 20234. Telephone: 301/921-2121.

Antenna and Field Strength Measurements

The emphasis of this seminar will be on high-accuracy gain and polarization measurements of microwave antennas. Powerful near-field techniques, recently developed at NBS, will be covered in detail. Recent advances in field strength measurements and calibration of field intensity meters will be presented along with techniques for the calibration and use of power density meters with special reference to radiation hazards.

For additional information on fees and prerequisites, contact Ramon Baird, Fields and Antennas Section, National Bureau of Standards, Boulder, Colo. 80302. Telephone: 303/499-3301.

Precision Thermometry Seminars

Three seminars in precision thermometry will be conducted: platinum resistance thermometry, liquid-in-glass thermometry and thermocouple thermometry. The seminars will be conducted sequentially. In general, attendance at each seminar will be kept

small in order to establish a close rapport with the attendees during the lecture and laboratory sessions. The material presented will include the definition and discussion of the International Practical Temperature Scale of 1968, methods for realizing values of temperature on the scale, thermometers and instrumentation and the treatment of calibration data. Time will be scheduled so that attendees will receive exposure to and participate in calibration measurements in the laboratories.

March 10 & 11, 1975	Platinum Resistance Thermometry	Fee: $100
March 12, 1975	Liquid-in-Glass Thermometry	Fee: $ 30
March 13, 1975	Thermocouple Thermometry	Fee: $ 60
March 14, 1975	Individual Laboratory and NBS tour	

Applications to attend a thermometry seminar should be received no later than February 14, 1975. Correspondence should be directed to: Dr. James F. Schooley, Temperature Section, Bldg. 221, National Bureau of Standards, Washington, D.C. 20234. Telephone: 301/921-2801.

Low Frequency Electrical Measurement

A 4-day seminar will present information on the accurate measurement of electrical quantities and the calibration of electrical standards. Each day of the seminar will be devoted to a general area of concern in electrical measurements, i.e., Monday—classical electrical measurements: Tuesday—electronic electrical measurements; Wednesday—power and energy measurements and Thursday—data analysis and automation. The program will consist of lectures, demonstrations in NBS Electricity Division laboratories and small group seminars discussing measurement problems of a more specific nature. The primary objective of the lectures is to present acceptable measurement methodology for industrial and general standards laboratory application. The methods used at NBS and new approaches being studied will also be considered.

Candidates must have undergraduate college-level training in physics or electrical engineering and must be currently engaged in professional work in precise electrical measurements at a level involving the basic reference standards of a calibration or standards laboratory. Preference will be given to those whose position involves the training of others in precise electrical measurements.

Attendance will be limited to 50 persons and for laboratory demonstrations each group will be divided into subgroups. The course will be offered on April 21-24, 1975, and the fee is $200. Apply to: George Free, Electricity Division, National Bureau of Standards, Washington, D.C. 20234. Telephone: 301/921-2715.

Frequency Standards and Clocks: Characterization Usage, Problem Areas

This seminar is intended for engineers and scientists involved in the design, specification, use and systems application of precision frequency standards and clocks. The seminar will feature presentations and laboratory demonstrations by NBS scientists as well as other experts on the following topics:

- Concepts of frequency stability.
- Measurement methods (frequency and time domain).
- Time errors and prediction.
- Clock simulation.
- Design concepts of standards.
- Causes for instability and drift in standards.
- Environmental effects on standards.
- Observation effects in clock networks (Doppler, relativity, propagation).

Participants should have a college degree (or equivalent) in electrical engineering or the natural sciences. Attendance will be limited to approximately 25 persons. The fee for the course to be given August 25-27, 1975, is $400. Apply to: David Allan or Helmut Hellwig, National Bureau of Standards, Boulder, Colo. 80302. Telephone: 303/499-1000, x3276.

APPLICATION FOR REGISTRATION
NBS MEASUREMENT SEMINARS

Title and date of seminar: _____

Date of application: _____

Applicant's name and address: _____

Company or agency affiliation: _____

Title of position in company or agency: _____

College level training: _____

Supervisory or laboratory experience related to measurement: _____

Citizenship: _____

Reprints of the material to be reviewed prior to the seminar will be mailed upon acceptance of this application.
Make registration fee payable to: National Bureau of Standards.

Survey Shows Schools Going Metric

THERE's something new going on in classrooms across the country. Little Johnnie and Susie are being taught liters and meters, in place of quarts and yards. Grams are beginning to replace ounces. Fahrenheit is giving way to Celsius.

For parents, who threw up their arms in despair when the new math was introduced more than a decade ago, there is some comfort. Learning metric is much simpler.

A recent survey of state education departments shows the swing to metric is accelerating. All but one state has underway some type of statewide activity related to teaching metric, the survey found. Some states plan to convert all textbooks to metric by 1976 or 1980 while others hope to be teaching metric as the principal measurement system by 1984.

The survey was conducted by the Metric Information Office of the Commerce Department's National Bureau of Standards (NBS).

"This survey shows how widespread the metric activity is in the education area. It is most encouraging that the schools are keeping pace with industry's change to metric," stated Jeffrey V. Odom, head of NBS' Metric Information Office. Because metric measurements are based on the decimal system and are more rational than the Customary measurements, students have little difficulty adapting to metric, he noted.

Odom said that Arkansas, the only state not reporting statewide metric activity in the survey, has underway local programs to brief teachers on the metric system.

Fourteen state school boards have adopted formal "go metric" resolutions and seven state legislatures have enacted laws directing the teaching of metric in public schools, the survey showed.

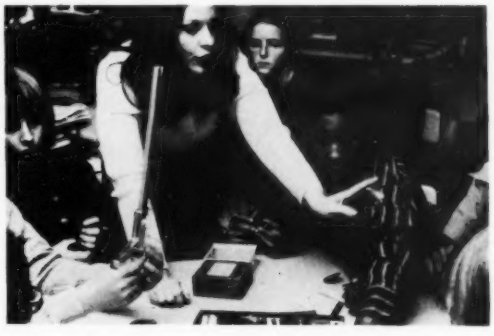
Forty-three states listed other categories of metric activity: Eighteen states have held or are holding workshops to acquaint teachers with the metric system; eight states have produced educational television films or other visual materials; eight states have produced teachers guides, pamphlets and other written materials, and twelve states have formed metric committees to assist in the conversion process.

Some examples of state metric activity:

In Alabama, the state legislature adopted a metric resolution in September, 1973, and the state school system has begun workshops for teachers. "There is rather widespread metric interest and activity throughout the state," reported J. Zac Perry, a mathematics specialist with the state Department of Education.

In California, the state Board of Education last May approved guidelines under which all mathematics textbooks will be converted to metric for kindergarten through eighth grade by September, 1976. Training of teachers has begun.

In Delaware, the Board of Education adopted a resolution last February whereby metric will be introduced into all public schools by the 1976-77 school year and will become the exclusive measurement system by the 1980-81 school year. The Board sponsored a "Think Metric Week" in October.



In Indiana, there has been no formal "go metric" resolution but teachers' workshops have been held and the Governor, Board of Education and state legislature have appointed committees to study the impact and needs of metrication.

In New Jersey, the state Department of Education is working with the New Jersey Public Broadcasting Authority to plan a television series for the general public.

In South Carolina, more than 5,700 teachers have attended 51 metric workshops in the last two school years.

Amendments to the Elementary and Secondary Education Act of 1965, which were signed into law last August, give the U.S. Office of Education prime responsibility for metric education. The legislation stated "it is the policy of the United States to . . . prepare students to use the metric system of measurement. . . ." □

NBS Strengthens Consumer Programs

THE National Bureau of Standard's Institute for Applied Technology (IAT) has made a major reorganization to provide more breadth and depth to its programs relating to consumer product technology.

A new operating unit, the Center for Consumer Product Technology, has been created within IAT to coordinate this important area. It will perform research on and develop methods of measuring and testing consumer products and law enforcement equipment for safety, energy efficiency and other performance characteristics. The new Center will be responsible for managing programs funded both directly by the Bureau and by other agencies such as the Consumer Product Safety Commission and the National Institute of Law Enforcement and Criminal Justice.

Within the new Center are four separate units concerned with specific aspects of consumer product technology. These are the Office of Consumer Product Safety, the Law Enforcement Standards Laboratory, the Product Engineering Division and the Product Systems Analysis Division.

The Office of Consumer Product Safety, which replaces the former Programmatic Center for Consumer Product Safety, is the focal point for Bureau work performed for the Consumer Product Safety Commission.

The Law Enforcement Standards Laboratory directs all work done at the Bureau for the National Institute of Law Enforcement and Criminal Justice.

The Product Engineering Division concentrates its efforts on product performance engineering and does electronic instrumentation design, upon request, for other NBS units and other agencies.

The Product Systems Analysis Division conducts the Bureau's program for labeling home appliances for energy efficiency. In addition it has responsibility for studying human factors involved in the design, use and abuse of products, as well as the features of products that lead to accidents. □

NBS, Industry to Join in Ethylene Study

A definitive set of thermophysical and related thermodynamic properties of ethylene will be developed as a result of a joint project being undertaken by the National Bureau of Standards and seven industrial firms.

Ethylene is a major item of commerce and is currently produced in the United States at the rate of 10 million metric tons (11 million tons) per year, which ranks it fourth in chemical production. It is used, handled and transported in the gaseous or liquid state.

Such properties as the density of the gas or liquid as a function of temperature and pressure, the extent of the gaseous and liquid regions, the enthalpy and the heat capacity are needed for handling ethylene in the plant, for equipment design and for custody transfer.

Although there are formulations for these properties which cover limited ranges of pressure and temperature satisfactorily, there is no adequate comprehensive self-consistent set of properties. The new project is designed to fill this need.

The project, which will be managed by the NBS Office of Standard Reference Data, will require experimental measurements and data evaluation. Experimental measurements will be carried out at the NBS laboratories in Gaithersburg, Md. and Boulder, Colo.; Department of Interior's Bureau of Mines Energy Research Center at Bartlesville, Okla.; and the University of Michigan. Data evaluation will be carried out at NBS laboratories in Boulder.

Financial support will be provided by the NBS Office of Standard Reference Data and the following companies: Celanese Chemical Company, Cities Service Oil Company, Continental Oil Company, Gulf Oil Corporation, Mobil Chemical Company, Monsanto Polymers and Petrochemicals Company and Union Carbide Corporation. It is expected that the project will take 5 years to complete.

For further information, call Dr. David Lide, Chief, Office of Standard Reference Data, National Bureau of Standards, Washington, D.C. 20234. □

New Flammability Standard for Sleepwear

TECHNICAL work performed by the National Bureau of Standards was the basis for a mandatory Federal standard for older children's sleepwear recently issued by the U.S. Consumer Product Safety Commission (CPSC).

The new standard, designed to reduce the painful injuries and loss of life caused when sleepwear worn by children ages 6 to 12 catches fire, takes effect May 1, 1975. It requires that all sleepwear sizes 7-14 manufactured on or after that date not exceed certain limits of flammability.

The NBS-developed test for the new standard consists of exposing five fabric samples, each 25.4 centimeters (10 inches) in length, to an open flame for 3 seconds. The average char length sustained by these samples must not exceed 17.8 centimeters (7 inches) nor should any of the samples burn its entire length.

The NBS study which recommended this standard found that children between the ages of 6 and 12 are susceptible to sleepwear fires as are those under 6, for whom a mandatory Federal flammability standard already exists.

NBS also found that kitchen ranges are the most predominant ignition source for this age group, with girls involved much more frequently than boys.

These findings are detailed in NBS Technical Note 810, "Fire Incidents Involving Sleepwear Worn by Children Ages 6-12," prepared by James A. Slater, a mathematician in the Bureau's Programmatic Center for Fire Research.

The report states that almost one fourth of those incidents recorded in NBS' Flammable Fabrics Accident Case and Testing System (FFACTS) in which sleepwear was the first item ignited involved children in the 6-12 group, while another one-fourth involved children under age 6. These facts led NBS to recommend to CPSC that 6-12 year olds be afforded protection similar to that which the 0-5 age group now receives under the Federal flammability standard.

The fact that many more females than males are involved in sleepwear fires is a pattern that begins with 6-12 year olds and continues, according to Slater, throughout all higher age groups. Girls were involved almost four times as frequently as boys in the FFACTS sleepwear incidents for the 6-12 age group. This differs from the more nearly equal proportions of males and females found in the 0-5 group.

The most typical sleepwear fire for the 6-12 age group occurs when a girl reaches across or leans against a kitchen range. Slater cites the dangling cuffs and sleeves of sleepwear garments and the loose draping ends of pajama tops as potentially dangerous points of contact with a hot burner. Other ignition sources reported to FFACTS for this age group include matches, furnaces, open fires and candles.

Full scale mannequin studies of fabrics similar to those found in FFACTS were conducted at NBS. The studies revealed that flames spread over a child's entire garment very rapidly—between 20 and 30 seconds after ignition—and account for the high degree of injury sustained from sleepwear ignitions.

Fifty-two of 74 victims in the 6-12 group on whom information was available to FFACTS required hospitalization while five other victims died from injuries sustained during these incidents. Slater says "These children would not have been severely burned had the sleepwear they were wearing been flame retardant."

Also included in this report are findings from NBS tests on fabric remnants involved in FFACTS sleepwear incidents and an examination of the fire hazards presented by the exposure of nightgowns to such heat sources as space heaters and fireplaces.

Printed copies of this publication, NBS Technical Note 810, may be ordered prepaid for 50 cents by SD Catalog No. C13.46:810 from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Foreign remittances must be in U.S. exchange and include an additional 25 percent of the publication price to cover mailing costs. Order microfiche copies prepaid by NBS designation from the National Technical Information Service, Springfield, Virginia 22151; the price is $1.45. (domestic) or $2.95 (foreign) a copy. □

Addendum

The names of two important contributors to the work on warning lights featured in the September 1974 issue of DIMENSIONS/NBS (p. 198) were inadvertently omitted. They are Charles A. Douglas and William F. Mullis of the Optical Radiation Section of NBS' Institute for Basic Standards.

one or more incidents or injuries. Since more than 200 households reported multiple incidents, the total number of fire incidents reported was 2,463. Injuries reported totaled 139, with a single death. Based on these data, and a careful application of weighting factors to account for the sample structure, the estimated total number of fires in the United States for the categories surveyed is 5,575,000 with over 4.5 million in residences and 1 million in the other categories covered by the incident portion of the survey. It must be remembered that these figures, and those that follow, do not include the fire experience in places of business, in public places, catastrophes which wipe out families and the other categories previously mentioned.

On the other hand, the survey does include minor fires. The 2.6 million cooking fires include 1.6 million grease fires, most of which were minor. Out of 3.5 million fires for which the pre-ignition activity was known, smoking and playing with matches were identified in 300,000 and 130,000 incidents respectively. Looking at the source of ignition, appliances predominate. Even subtracting 1,872,000 grease and food fires from the 3.4 million incidents involving appliances, leaves the appliance category in first place. Within that category, kitchen ranges account for 1.2 million cases, appliances not further identified total 1.2 million and television sets total 200,000. The room of origin tabulation, for residential fires only, reinforces the other data by showing the kitchen as the room of origin in 65 percent of the cases.

Preliminary analysis of property loss data shows 2.4 million fires accounting for 1.5 billion dollars in loss, with no loss reported for 2.9 million incidents. One billion dollars of loss was incurred in residences, and ¼ billion each in other buildings on residential property and in motor vehicles owned by household members.

The number of injuries is estimated at over 325,000. This estimate includes over 140,000 injuries at home, and 185,000 away from home. Whereas overall, injuries to males accounted for 62 percent of the total, they were only 39 percent of the total in fire accidents at home, but a predominant 80 percent of the total in fires away from home. It is expected that the total number of injuries away from home is underestimated by a substantial amount, since the information on injuries to household members away from home is based on the knowledge and recall of the single household member responding. Out of the estimated 327,000 persons injured, 64 percent received first aid, 31 percent were treated at a hospital emergency room and 7 percent were hospitalized at least overnight.

In order to get a feeling for the role of fabric items in fire incidents, let us consider the number of incidents in which fabric items were first-to-ignite. Interior furnishings (carpets, rugs, curtains, draperies, upholstered furniture) were first-to-ignite in an estimated 285,000 incidents, clothing in 159,000 incidents, bedding in 115,000 incidents and other fabric items in 69,000 incidents, for a total of 628,000 fabric items first-to-ignite.

This initial U.S. household survey of fire experience will yield useful data, while raising many new questions. It does, however, provide further insight into the magnitude of this segment of the national fire picture. These data, along with data from subsequent surveys, will be incorporated into the National Fire Data System (NFDS), which has been moved from NBS to the newly established National Fire Protection and Control Administration. NFDS, in turn, will quantify U.S. fire losses, identify acute problem areas, establish priorities for fire research and measure the effectiveness of current fire programs. In short, it will provide the information necessary for a continuing attack on America's fire problem. □

PUBLICATIONS

of the National Bureau of Standards

Building Technology

Cooke, P. W., Tejuju, H. K., Dikkers, R. D., and Zelenka, L. P., *State Building Regulatory Programs for Mobile Homes and Manufactured Buildings—A Summary*, Nat. Bur. Stand. (U.S.), Tech. Note 853, 35 pages (Sept. 1974) SD Catalog No. C13.46:853, 85 cents.

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Highland, H. J., Ed., *Computer Performance Evaluation. Proceedings of the Eighth Meeting of Computer Performance Evaluation Users Group [CPEUG], held at NBS, Gaithersburg, Md., December 4-7, 1973*, Nat. Bur. Stand. (U.S.), Spec. Publ. 401, 155 pages (Sept. 1974) SD Catalog No. C13.10:401, $1.80.

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Stewart, S. L., Ed., *Report on Planning Session on Software Engineering Handbook*, Nat. Bur. Stand. (U.S.), Tech. Note 832, 18 pages (Nov. 1974) SD Catalog No. C13.46:832, 70 cents.

Health and Safety

Kapsch, R. J., Ed., *Health and Medical Facilities Design. Proceedings of the First Federal Agency Workshop, held at the National Bureau of Standards Gaithersburg, Md., December 5, 1972*, Nat. Bur. Stand. (U.S.), Bldg. Sci. Ser. 54, 87 pages (July 1974) SD Catalog No. C13.29/2:54, $1.25.

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Gatts, R. R., Massey, R. G., and Robertson, J. C., *Energy Conservation Program Guide for Industry and Commerce (EPIC)*, Nat. Bur. Stand. (U.S.), Handb. 115, 212 pages (Sept. 1974) SD Catalog No. C13.11:115, $2.50.

Engineering, Product and Information Standards

Reed, S. K., Ed., *Guidelines for Automatic Data Processing Physical Security and Risk Management*, Nat. Bur. Stand. (U.S.), Fed. Info. Process. Stand. Publ. (FIPS PUB), 31, 92 pages (1974) SD Catalog No. C13.52:31, $1.35.

Roundtree, R. E., *Character Set for Handprinting*, Nat. Bur. Stand. (U.S.), Fed. Info. Process. Stand. Publ. (FIPS PUB) 33, 4 pages (1974) SD Catalog No. C13.52:33, 25 cents.

Low Temperature Science and Engineering

Roder, H. M., *Liquid Densities of Oxygen, Nitrogen, Argon and Parahydrogen*, Nat. Bur. Stand. (U.S.), Tech. Note 361 (Revised), (Metric Supplement), 114 pages (June 1974) SD Catalog No. C13.46:361 (Rev.), Metric Supplement, $1.25.

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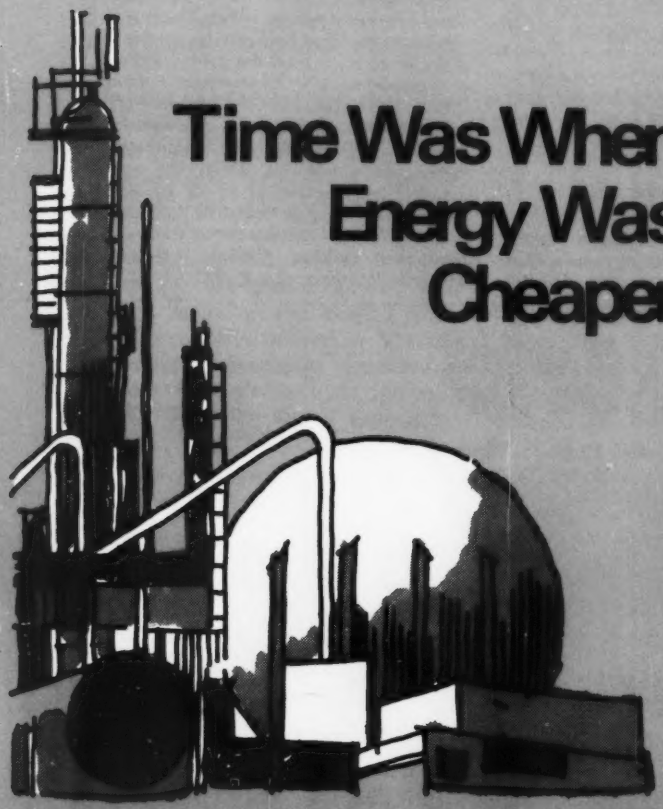
Freese, R., and Johnson, C. R., *Comments on the Discrete Matrix Model of Population Dynamics*, J. Res. Nat. Bur. Stand. (U.S.), *78B* (Math. Sci.), No. 2, pp. 73-78 (Apr.-June 1974).

Goldman, A. J., *Fixed-Point Solution of Plant Input/Location Problems*, J. Res. Nat. Bur. Stand. (U.S.), *78B* (Math. Sci.), No. 2, pp. 79-94 (Apr.-June 1974).

Minsker, S., *A New Proof of Pick's Theorem*, J. Res. Nat. Bur. Stand. (U.S.), *78B* (Math. Sci.), No. 2, pp. 95-96 (Apr.-June 1974).

Publications listed here may be purchased at the listed price from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (foreign: add 25%). Microfiche copies are available from the National Technical Information Service, Springfield, Va. 22151. For more complete periodic listings of all scientific papers and articles produced by NBS staff, write: Editor, Publications Newsletter, Administration Building, National Bureau of Standards, Washington, D.C. 20234.



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